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TRANSMITTAL FORM

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Total Number of Pages in This Submission

Application Number	10/758,552
Filing Date	01/15/2004
First Named Inventor	Wagner
Art Unit	1725
Examiner Name	C. A. Johnson
Attorney Docket Number	20031231-001

ENCLOSURES *(Check all that apply)*

- [x] Fee Transmittal Form
  - [x] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [x] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Remarks

Credit Card Payment Form
Return Receipt Postcard

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Joan L. Simunic		
Signature	Joan Simunic		
Printed name	Joan L. Simunic		
Date	December 30, 2005	Reg. No.	43,125

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as ~~first class~~ Express mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Joan Simunic		
Typed or printed name	Joan L. Simunic	Date	December 30, 2005

PTO/SB/17 (12-04v2)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($)	500.00

Complete if Known	
Application Number	10/758,552
Filing Date	01/15/2004
First Named Inventor	Wagner
Examiner Name	C. A. Johnson
Art Unit	1725
Attorney Docket No.	2003231-001

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☐ Deposit Account Deposit Account Number: _____ Deposit Account Name: _____

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	FILING FEES Small Entity Fee ($)	SEARCH FEES Fee ($)	SEARCH FEES Small Entity Fee ($)	EXAMINATION FEES Fee ($)	EXAMINATION FEES Small Entity Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims	Extra Claims	Fee ($)	Fee Paid ($)
_____ - 20 or HP =	_____	x _____	= _____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims	Extra Claims	Fee ($)	Fee Paid ($)
_____ - 3 or HP =	_____	x _____	= _____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims Fee ($)	Multiple Dependent Claims Fee Paid ($)
_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee ($)	Fee Paid ($)
_____ - 100 =	_____	/ 50 = _____ (round up to a whole number)	x _____	= _____

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Filing of Appeal Brief	500.00

SUBMITTED BY

Signature		Registration No. (Attorney/Agent) 43,125	Telephone (502) 220-1184
Name (Print/Type)	Joan L. Simunic		Date December 30, 2005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Number	:	10/758,552	Confirmation No.: 5985
Applicants	:	Wagner et al.	
Filing Date	:	01/15/2004	
TC/A.U.	:	1725	
Examiner	:	Christina Ann Johnson	
Attorney Docket No.	:	20031231-001	
Title:	:	Catalyst for Production of Hydrogen	

Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

APPEAL BRIEF

Sir:

Applicant submits the following brief in support of its appeal of the rejection of all claims in application serial number 10/758,552.

Real party in interest.

The real party in interest in this matter is Süd-Chemie, Inc., the assignee of the entire interest in the application.

Related appeals and interferences.

There are no related appeals or interferences relative to application serial number 10/758,552.

Status of claims.

Claims 1 – 8 and claims 11 – 17 and claims 19 – 20 have been rejected by the Examiner. Claims 9, 10 and 18 have been canceled from the application. Claims 1 – 8, 11 – 17 and 19 – 20 are being appealed.

Status of amendments.

No amendments were filed subsequent to the final rejection.

Summary of claimed subject matter.

The present development is a catalyst for use in the water-gas-shift reaction. As amended, the claims require that the catalyst includes a primary transition metal selected from the group consisting of Group VIII metals, Group IB metal, cadmium and a combination thereof; a transition metal promoter

selected from the group consisting of rhenium, niobium, silver, manganese, vanadium, molybdenum, titanium, tungsten and a combination thereof; and a support comprising cerium oxide and an additive selected from gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten and combinations thereof. The primary transition metal and the transition metal promoter may each comprise up to about 20 wt% of the catalyst, and in a preferred embodiment the primary transition metal concentration is greater than the transition metal promoter concentration.

The present development also includes a process for preparing a platinum and rhenium promoted catalyst having a ceria support for use in the water-gas-shift reaction. In a preferred embodiment, the process involves providing "clean" precursors as starting materials in the catalyst preparation.

Independent Claim 1 is presented on pages 7 and 8 of this paper. Independent Claim 8 is presented on pages 7, 10 and 11 of this paper. Independent Claim 13 is presented on pages 7, 12 and 13 of this paper. Claims 2 – 7 depend from independent Claim 1, and will stand or fall with Claim 1, and are presented on page 9 of this paper. Claims 11 and 12 depend from independent Claim 8, and will stand or fall with Claim 8, and are presented on page 11 of this paper. Claims 14 – 17 and 19 – 20 depend from independent Claim 13, and will stand or fall with Claim 13, and are presented on page 14 of this paper.

Grounds of rejection to be reviewed on appeal.

The Examiner has rejected claims 1 – 8, 11 – 17, 19 and 20 under 35 U.S.C. 103(a) as obvious over Igarashi (JP2000-342968, EP 1 161 991) in view of Silver (U.S. Patent 6,455,182, "the '182 patent"). Specifically, the Examiner has stated that "it would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the catalyst taught by the WO reference [the '991 application] to include the use of a mixed cerium oxide – zirconium oxide support as taught by Silver." Applicant respectfully contends that the Examiner has not established a prima facie case of obviousness and hence, the claims of the present application cannot be rejected under 35 U.S.C. 103(a).

Argument.

According to the MPEP §706.02(j), "[t]o establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck,* 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)."

Claims 1 – 7, Claim 8, Claims 11 – 12, and Claim 19.

The independent Claims 1 and 8, and dependent Claims 2 – 7, 11 – 12 and 19, of the present application each claim a catalyst that requires (1) the combination of a primary transition metal and a transition metal promoter (2) wherein a ratio defined by [Primary TM]:[Promoter] is greater than 1:1 (3) on a support comprising cerium oxide and an additive. This three-prong combination is not taught or suggested in the prior art.

1. *There is no suggestion or motivation, either in the '991 application or the '182 patent, or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings.*

"Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art." (MPEP 2143.01.I) "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)." (MPEP 2143.01.III). "A statement that modifications of the prior art to meet the claimed invention would have been 'well within the ordinary skill of the art at the time the claimed invention was made' because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). See also *In re Kotzab*, 217 F.3d 1365, 1371, 55 USPQ2d 1313, 1318 (Fed. Cir. 2000) (Court reversed obviousness rejection involving technologically simple concept because there was no finding as to the principle or specific understanding within the knowledge of a skilled artisan that would have motivated the skilled artisan to make the claimed invention); *Al-Site Corp. v. VSI Int'l Inc.*, 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999) (The level of skill in the art cannot be relied upon to provide the suggestion to combine references.)" (MPEP 2143.01.IV).

The '991 Application

The '991 application teaches a catalyst for a water gas shift reaction wherein the catalyst comprises at least platinum, which may be used in combination with rhenium, on a metal oxide support, and wherein the ratio of platinum to rhenium is greater than 1:1, but fails to teach or suggest a support comprising cerium oxide and an additive. Specifically, within the specification of the '991 application there is an express, and closed, recitation of possible metal oxide supports for use in the catalyst, all of which exclude ceria (cited are zirconia, alumina, titania, silica, silica-magnesia, zeolite, magnesia, niobium oxide, zinc oxide and chromium oxide (see paragraph [0011] and also claim 2)). The specification teaches that ceria may be used as a promoter for the catalyst. But, there is no teaching or suggestion to include ceria within the catalyst support.

Further, the specification of the '991 application at least suggests that one of ordinary skill in the art should NOT include ceria within the catalyst support for a catalyst prepared according to the teachings of the '991 application. When the '991 application was filed, cerium oxide was a known support material for platinum and rhenium water gas shift catalysts. In fact, the U.S. application related to the '991 application, U.S. application 09/720,262 (filed February 6, 2001; now issued as U.S. Patent 6,777,117) references a leading authority in the art: Bunluesin et al, "Studies of the Water-Gas-Shift Reaction on Ceria-Supported Pt, Pd, and Rh: Implications for Oxygen-Storage Properties", Applied Catalysis B: Environment, vol. 15 (1998), pp. 107-114. Presumably, the inventor for the '991 application is one of at least ordinary skill in the art, yet even in view of a cited reference that teaches platinum and rhenium water gas shift catalysts using ceria supports, the list of possible metal oxide supports for the catalyst of the '991 application *still* did not include ceria, or ceria used in combination with another metal, as part of the support, nor is the recitation of support materials open-ended to encourage the inclusion of ceria in the support.

Thus, there is no suggestion or motivation in the '991 application, or in the knowledge that was generally available to one of ordinary skill in the art at the time the present application was filed, to modify the '991 application teachings to include ceria in the support of a water gas shift catalyst comprising platinum and rhenium (or any primary transition metal and transition metal promoter).

The '182 Patent

The '182 patent teaches a shift converter in a fuel processing subsystem for a fuel cell that includes a catalyst comprising a noble metal catalyst having a promoted support of mixed metal oxides, including at least both ceria and zirconia. The '182 patent teaches that platinum, palladium, rhodium, and/or gold may be used in combination on the mixed metal oxide support. But, the '182 patent fails to teach or suggest that the noble metals should maintain a certain ratio relative to each other.

Specifically, the '182 patent provides little information at all about the noble metal catalyst to be used on the mixed metal oxide support. At column 2, line 58 of the '182 patent, the catalyst is identified as "a noble metal catalyst ..." with more details provided in column 3, lines 7 – 11: "The noble metal catalyst on the promoted support is selected from the metals of groups VIIb, VIII, and Ib of the second and third transition series of the periodic table, with platinum, palladium, rhodium, and gold being generally preferred, and platinum being particularly preferred." This listing does not teach or suggest that combinations thereof may be used, but rather specifies individual noble metals, and provides no relative ratio of the metals if used in combination. The suggestion that the noble metal catalysts are to be used individually and not in combination – so no ratio would be applicable – when used on a ceria – zirconia support is further evidenced by column 4, lines 23 – 24, where the '182 patent clearly refers to "a noble metal on a promoted support of mixed metal oxides, ..." The paragraph continues by teaching that the support may benefit from "the addition of one or more additional metal oxides, ..." but this same expansiveness is not extended to the noble metal catalyst. The '182 patent teaches an "exemplary formulation of and for the catalyst composition ..." and the "noble metal catalyst is platinum." (See column 4, lines 53 – 58.) An Example is set forth in column 5 of the '182 patent and teaches a catalyst composition that comprises only platinum as the noble metal catalyst. Finally, at column 6, lines 20 – 22 – "[t]he noble metal, or metals, that comprise(s) the catalyst supported by the mixed metal oxides of at least ceria and zirconia, is/are selected from ..." – is there any possible hint that more than one noble metal could be used on the support of the '182 patent. However, even then, the Markush grouping expressly fails to refer to any combination thereof or to make any reference that could be read as a suggestion to combine noble metals on the mixed oxide support. Only at column 6, lines 26 – 28, is any combination of metals taught or suggested: "Platinum, palladium, rhodium, and/or gold, alone or in combination, are generally preferred, and platinum is the noble metal that is particularly preferred." But, even here the '182 patent fails to teach or suggest that the noble metals should maintain a certain ratio relative to each other, and certainly not that there should be a primary transition metal and a transition metal promoter added such that a ratio defined by [Primary TM]:[Promoter] is greater than 1:1.

Similar to the specification of the '991 application, the specification of the '182 patent at least suggests that one of ordinary skill in the art should not combine more than a very short list of noble metals (platinum, palladium, rhodium, gold) on the mixed metal oxide support. When the '182 patent application was filed, it was known that one or more platinum group metals – and particularly platinum with iridium – could be deposited on a support comprising ceria, lanthana and alumina (U.S. Patent 4,170,573, issued October 9, 1979). In fact, the '182 patent cites the '573 patent as a reference to the '182 patent. Yet, even in view of a cited reference that teaches platinum and iridium catalysts supported on a ceria-based supported, the '182 patent fails to teach or suggest combinations of any noble metals except for platinum, palladium, rhodium and / or gold for use on a ceria-zirconia support.

Thus, there is no suggestion or motivation in the '182 patent, or in the knowledge that was generally available to one of ordinary skill in the art at the time the present application was filed, to modify the '182 patent teachings to include a combination of noble metals other than platinum, palladium, rhodium and / or gold, or to combine the metals such that a primary transition metal and a transition metal promoter are added to define a ratio ([Primary TM]:[Promoter]) that is greater than 1:1.

2. *There is no reasonable expectation of success, except in hindsight in view of the present invention.*

The '991 application and the '182 patent each left gaps within their teachings: the inventor of the '991 application failed to recognize that ceria could be included in the support of a water gas shift catalyst that used platinum and rhenium to produce a highly efficient water gas shift catalyst; the inventor of the '182 patent failed to recognize that platinum could be combined with metals other than palladium, rhodium and gold on a ceria-zirconia support to produce a highly efficient water gas shift catalyst. Because these inventors are believed to be of at least ordinary skill in the art, the omissions do not appear to be inadvertent. Rather, it would seem that each of these inventors did not believe that there was a reasonable expectation of success by making the combination of the present invention.

In contrast, the present applicants noted that there were gaps between the teachings of the '991 application and the '182 patent. They filled in the gap and identified a highly efficient water gas shift catalyst – a success. Thus, it is only through hindsight in view of the present invention that a successful water gas shift catalyst can be recognized, wherein the catalyst requires the combination of a primary transition metal and a transition metal promoter wherein a ratio defined by [Primary TM]:[Promoter] is greater than 1:1 on a support comprising cerium oxide and an additive.

3. *Neither the '991 application nor the '182 patent, taken alone or in combination teach or suggest all the claim limitations.*

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)." (MPEP 2143.03)

As noted above, neither the '991 application nor the '182 patent, taken alone, teach or suggest all the claim limitations of the present application:

The '991 application fails to teach or suggest the inclusion of ceria in the support material of a water gas shift catalyst that supports more than one noble metal catalyst, but does teach the use of a primary transition metal and a transition metal promoter in such a proportion that [Primary TM]:[Promoter] is greater than 1:1.

The '182 patent fails to teach or suggest the use of a combination of noble metals other than platinum, palladium, rhodium and / or gold on a mixed metal oxide support comprising ceria such that the noble metals define a ratio [Primary TM]:[Promoter] that is greater than 1:1.

Further, neither the '991 application nor the '182 patent, taken in combination, teach or suggest all the claim limitations of the present application:

The teachings in the '182 patent that limit metal combinations to platinum, palladium, rhodium and / or gold. Because of this, it is not possible to apply the platinum / rhenium metal combination taught in the '991 application to the support taught in the '182 patent will result in the invention of the present application.

The teachings in the '991 application that limit the support to zirconia, alumina, titania, silica, silica-magnesia, zeolite, magnesia, niobium oxide, zinc oxide and chromium oxide. Because of this, it is not possible to use the ceria-zirconia support taught in the '182 patent to support the platinum / rhenium metal combination taught in the '991 application will result in the invention of the present application.

Thus, neither the '991 application nor the '182 patent, taken alone or in combination teach or suggest all the claim limitations of the present application.

Claims 13 – 17 and Claim 20.

Independent Claim 13, and dependent Claims 14 – 17 and 20, of the present application each claim a catalyst that requires (1) the combination of a primary transition metal and a transition metal promoter (2) on a support comprising cerium oxide and an additive (3) that is prepared by impregnation of the support with the transition metals. This combination is not taught or suggested in the prior art.

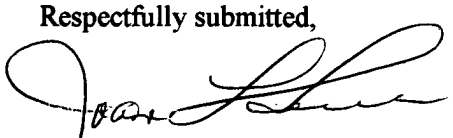
As noted in the argument in support of Claims 1 – 7, Claim 8, Claims 11 – 12 and Claim 19, the '991 application fails to teach or suggest the inclusion of ceria in the support material of a water gas shift catalyst that supports more than one noble metal catalyst and the '182 patent fails to teach or suggest the use of a combination of noble metals other than platinum, palladium, rhodium and / or gold on a mixed metal oxide support comprising ceria. Moreover, the teachings in the '182 patent limit the metal combinations to platinum, palladium, rhodium and / or gold and the teachings in the '991 application limit the support to zirconia, alumina, titania, silica, silica-magnesia, zeolite, magnesia, niobium oxide, zinc oxide and chromium oxide. Because it is not possible to get to the transition metal combination plus support of the present invention through either the '991 application or the '182 patent, taken alone or in combination, the catalyst prepared in Claims 13 – 17 and 20 is novel and non-obvious so the preparation thereof is novel and non-obvious.

Claims appendix. Claims 1 – 8, 11 – 17 and 19 – 20 are being appealed and are presented in the Claims Appendix beginning on page __ of this paper.

Evidence appendix. No evidence pursuant to MPEP §§ 1.130, 1.131, or 1.132 has been presented in support of application serial number 10/758,552.

Related proceedings appendix. No decisions have been rendered by a court or the Board in any proceeding related to application serial number 10/758,552.

Respectfully submitted,



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Summary of Claimed Subject Matter by Claim with References to Specification to Support Claim

Independent Claim 1 claims a catalyst suitable for the production of hydrogen. The catalyst consists essentially of a primary transition metal present at a predetermined concentration [Primary TM], and a transition metal promoter present at a predetermined concentration [Promoter], and a support material comprising cerium oxide and an additive. The transition metal and the promoter are combined with the support material to form the catalyst. The primary transition metal is selected from the group consisting of a Group VIII metal, a Group IB metal, cadmium and a combination thereof. The promoter is selected such that a ratio defined by [Primary TM]:[Promoter] is greater than 1:1. The support material additive is selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof.

See also the claim elements table on page 8 with references to specification pages and line numbers.
A claim elements table for dependent Claims 2 – 7 is provided on page 9.

Independent Claim 8 claims a catalyst comprising a primary transition metal present at a predetermined concentration [Primary TM] of up to about 20 wt%, a transition metal promoter present at a predetermined concentration [Promoter], and a support material comprising cerium oxide at a concentration of greater than about 10 wt%, and an additive present at a concentration of up to about 90 wt%. The primary transition metal is selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof. The transition metal promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof. The support material additive is selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof. The transition metal and the promoter are combined with the support material to form the catalyst and a ratio defined by [Primary TM]:[Promoter] is greater than 1:1.

See also elements table on pages 10 – 11 with references to specification pages and line numbers.
A claim elements table for dependent Claims 11 – 12 is provided on page 11.

Independent Claim 13 claims a catalyst having a transition metal impregnated onto a support material to form a transition metal inclusive support which is then calcined; and a transition metal promoter is then impregnated onto the calcined transition metal inclusive support and is calcined to form a promoter inclusive catalyst. The primary transition metal is present at a predetermined concentration [Primary TM] of up to about 20 wt%, the transition metal promoter is present at a predetermined concentration [Promoter], and the support material comprises cerium oxide at a concentration of greater than about 10 wt% and an additive present at a concentration of up to about 90 wt%. The primary transition metal is selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof. The transition metal promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof. The support material additive is selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof.

See also elements table on pages 12 – 13 with references to specification pages and line numbers.
A claim elements table for dependent Claims 14 – 17 and 19 – 20 is provided on page 14.

The bases for independent Claim 1 are found within the specification as follows:

Claim Limitation	Basis Citation
A catalyst suitable for production of hydrogen, said catalyst consisting essentially of:	Page 5, Lines 2 – 3: "The catalyst of the present invention is intended for use as a water-gas-shift (WGS) catalyst in a reaction suitable for conversion of hydrogen for chemical processing."
a. a primary transition metal	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
selected from the group consisting of a Group VIII metal, a Group IB metal, cadmium and a combination thereof,	Page 6, Lines 13 – 18: "... platinum function well as a primary transition metal ... However, other metals or combinations of metals, particularly the Group VIII and Group IB transition metals, such as iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, gold, and cadmium and rhenium may be substituted for or may be added to the platinum ..."
said primary transition metal being present at a predetermined concentration [Primary TM];	Page 6, Lines 19 – 21: "The primary transition metal – as a single metal or as a combination of metals – is present in the catalyst at a predetermined concentration ("[Primary TM]") ..."
b. a transition metal promoter	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
present at a predetermined concentration [Promoter]	Page 7, Lines 8 – 9: "... the transition metal promoter concentration ("[Promoter]") is lower than the concentration of the primary transition metal."
selected such that a ratio defined by [Primary TM]:[Promoter] is greater than 1:1; and	Page 5, Lines 5 – 9: "The transition metal promoter ... is preferably present in the catalyst at a concentration such that the [primary transition metal]:[promoter] is greater than 1:1, *i.e.* the promoter concentration must be less than the primary transition metal concentration."
c. a support material comprising cerium oxide	Page 7, Lines 18 – 19: "The water-gas-shift catalyst support of the present invention comprises a ceria-based material that is present at a concentration greater than about 10 wt%."
and an additive	Page 8, Lines 4 – 6: "To enhance the CeO_2 performance, additives ... may be used in the ceria-based support."
selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof,	Page 8, Lines 4 – 6: "To enhance the CeO_2 performance, additives such as gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium or a combination thereof may be used in the ceria-based support."
wherein said transition metal and said promoter are combined with said support material to form said catalyst.	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."

The bases for dependent Claims 2 – 7 are found within the specification as follows:

Claim	Claim Limitation	Basis Citation
Claim 2	The catalyst of Claim 1 wherein said primary transition metal is present at a concentration of up to about 20 wt%.	Page 6, Lines 19 – 21: "The primary transition metal – as a single metal or as a combination of metals – is present in the catalyst at a predetermined concentration ("[Primary TM]") of up to about 20 wt%, including the weight of the primary transition metal."
Claim 3	The catalyst of Claim 2 wherein said primary transition metal is selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof.	Page 6, Lines 13 – 18: "... platinum function well as a primary transition metal ... However, other metals or combinations of metals, particularly the Group VIII and Group IB transition metals, such as iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, gold, and cadmium and rhenium may be substituted for or may be added to the platinum ..."
Claim 4	The catalyst of Claim 1 wherein said promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof.	Page 7, Lines 4 – 6: "... the transition metal promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, ruthenium, rhodium, iridium, silver, the Group VIII metals, the Group IB metals and a combination thereof, ..."
Claim 5	The catalyst of Claim 1 wherein said support material comprises cerium oxide at a concentration of greater than about 10 wt%.	Page 7, Lines 18 – 19: "The water-gas-shift catalyst support of the present invention comprises a ceria-based material that is present at a concentration greater than about 10 wt%."
Claim 6	The catalyst of Claim 1 wherein said support material has a surface area of from about 10 m^2/g to about 200 m^2/g.	Page 7, Line 23 – Page 8, Line 1: "Further, the cerium oxide has a surface area of from about 10 m^2/g to about 200 m^2/g ..."
Claim 7	The catalyst of Claim 1 wherein said catalyst is combined with a substrate, wherein said substrate is a monolith, a foam, a sphere, an extrudate, a tab, a pellet, a multi-passage substrate or a combination thereof.	Page 5, Lines 23 – 24: "The present catalyst may similarly be delivered on a variety of substrates, such as monoliths, foams, spheres, or other forms as are known in the art." Page 11, Lines 7 – 8: "For example, the present catalyst may be delivered in the form of extrudates, tabs, pellets, multi-passage substrates or similarly prepared materials."

The bases for independent Claim 8 are found within the specification as follows:

Claim Limitation	Basis Citation
A catalyst suitable for conversion of hydrogen, said catalyst comprising:	Page 5, Lines 2 – 3: "The catalyst of the present invention is intended for use as a water-gas-shift (WGS) catalyst in a reaction suitable for conversion of hydrogen for chemical processing."
a. a primary transition metal	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
present at a predetermined concentration [Primary TM] of up to about 20 wt% and	Page 6, Lines 19 – 21: "The primary transition metal – as a single metal or as a combination of metals – is present in the catalyst at a predetermined concentration ("[Primary TM]") of up to about 20 wt%, including the weight of the primary transition metal."
selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof;	Page 6, Lines 13 – 18: "... platinum function well as a primary transition metal ... However, other metals or combinations of metals, particularly the Group VIII and Group IB transition metals, such as iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, gold, and cadmium and rhenium may be substituted for or may be added to the platinum ..."
b. a transition metal promoter	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
present at a predetermined concentration [Promoter] and	Page 7, Lines 8 – 9: "... the transition metal promoter concentration ("[Promoter]") is lower than the concentration of the primary transition metal."
selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof; and	Page 7, Lines 4 – 6: "... the transition metal promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, ruthenium, rhodium, iridium, silver, the Group VIII metals, the Group IB metals and a combination thereof, ..."
c. a support material comprising cerium oxide	Page 7, Lines 18 – 19: "The water-gas-shift catalyst support of the present invention comprises a ceria-based material that is present at a concentration greater than about 10 wt%."
at a concentration of greater than about 10 wt%,	Page 7, Lines 18 – 19: "The water-gas-shift catalyst of the present invention comprises a ceria-based material that is present at a concentration of greater than about 10 wt%."
and an additive	Page 8, Lines 4 – 6: "To enhance the CeO_2 performance, additives ... may be used in the ceria-based support."
present at a concentration of up to about 90 wt% and	Page 5, Lines 10 – 13: "... the support may include an additive, ... which may be added to the support at a concentration of from about 0 wt% to about 90 wt%."

Claim Limitation	Basis Citation
selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof,	Page 8, Lines 4 – 6: "To enhance the CeO_2 performance, additives such as gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium or a combination thereof may be used in the ceria-based support."
wherein said transition metal and said promoter are combined with said support material to form said catalyst and	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
a ratio defined by [Primary TM]:[Promoter] is greater than 1:1.	Page 5, Lines 5 – 9: "The transition metal promoter ... is preferably present in the catalyst at a concentration such that the [primary transition metal]:[promoter] is greater than 1:1, *i.e.* the promoter concentration must be less than the primary transition metal concentration."

The bases for dependent Claims 11 – 12 are found within the specification as follows:

Claim	Claim Limitation	Basis Citation
Claim 11	The catalyst of Claim 8 wherein said support material is a mixed cerium zirconium oxide comprising zirconium at a higher weight percent than cerium.	Page 8, Lines 15 – 19: "In the present development using a platinum primary metal and a rhenium promoter, it has been found that a cerium zirconium oxide support which is rich in zirconium, *i.e.* in which the weight percent added to the support by the zirconium is greater than the weight percent added to the support by the cerium, demonstrates a surprisingly improved level of CO conversion ..."
Claim 12	The catalyst of Claim 8 wherein said support material is a mixed cerium zirconium oxide comprising cerium at a higher weight percent than zirconium.	Page 8, Lines 21 – Page 9, Line 1: "Alternatively, a cerium zirconium oxide support which is rich in cerium, such as $Ce_{0.8}Zr_{0.2}O_2$ having a surface area greater than about 30 m^2/g, and preferably having a surface area of from about 50 m^2/g to about 150 m^2/g, has also shown acceptable levels of CO conversion ..."

The bases for independent Claim 13 are found within the specification as follows:

Claim Limitation	Basis Citation
A catalyst suitable for conversion of hydrogen for chemical processing, said catalyst comprising:	Page 5, Lines 2 – 3: "The catalyst of the present invention is intended for use as a water-gas-shift (WGS) catalyst in a reaction suitable for conversion of hydrogen for chemical processing."
a. a primary transition metal	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
present at a predetermined concentration [Primary TM] of up to about 20 wt% and	Page 6, Lines 19 – 21: "The primary transition metal – as a single metal or as a combination of metals – is present in the catalyst at a predetermined concentration ("[Primary TM]") of up to about 20 wt%, including the weight of the primary transition metal."
selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof;	Page 6, Lines 13 – 18: "... platinum function well as a primary transition metal ... However, other metals or combinations of metals, particularly the Group VIII and Group IB transition metals, such as iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, gold, and cadmium and rhenium may be substituted for or may be added to the platinum ..."
b. a transition metal promoter	Page 5, Lines 3 – 4: "The catalyst composition comprises a primary transition metal and a transition metal promoter supported on a ceria-based material."
present at a predetermined concentration [Promoter] and	Page 7, Lines 8 – 9: "... the transition metal promoter concentration ("[Promoter]") is lower than the concentration of the primary transition metal."
selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof; and	Page 7, Lines 4 – 6: "... the transition metal promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, ruthenium, rhodium, iridium, silver, the Group VIII metals, the Group IB metals and a combination thereof, ..."
c. a support material comprising cerium oxide	Page 7, Lines 18 – 19: "The water-gas-shift catalyst support of the present invention comprises a ceria-based material that is present at a concentration greater than about 10 wt%."
at a concentration of greater than about 10 wt%,	Page 7, Lines 18 – 19: "The water-gas-shift catalyst of the present invention comprises a ceria-based material that is present at a concentration of greater than about 10 wt%."
and an additive	Page 8, Lines 4 – 6: "To enhance the CeO_2 performance, additives ... may be used in the ceria-based support."
present at a concentration of up to about 90 wt% and	Page 5, Lines 10 – 13: "... the support may include an additive, ... which may be added to the support at a concentration of from about 0 wt% to about 90 wt%."

Claim Limitation	Basis Citation
selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof,	Page 8, Lines 4 – 6: "To enhance the CeO_2 performance, additives such as gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium or a combination thereof may be used in the ceria-based support."
wherein said transition metal is impregnated onto the support material to form a transition metal inclusive support	Page 11, Lines 15 – 16: "In the examples presented herein, the metals have been combined with the support using known impregnation techniques." See also, Examples 1 and 1A.
and said inclusive support is then calcined;	Page 12, Lines 13 – 15: "The impregnated powder is dried in an oven set at about 100°C for about 4 hours to about 24 hours, and the powder is then calcined in a furnace set at from about 300°C to about 500°C ..."
and said transition metal promoter is impregnated onto said inclusive support	Page 11, Lines 15 – 16: "In the examples presented herein, the metals have been combined with the support using known impregnation techniques." See also, Examples 2 and 2A.
and calcined to form a promoter inclusive catalyst.	Page 13, Lines 13 – 15: "The rhenium solution is added to the calcined Pt/CZO powder, ... and the powder is then calcined in a furnace set at from about 300°C to about 500°C ..."

The bases for dependent Claims 14 – 17 and 19 – 20 are found within the specification as follows:

Claim	Claim Limitation	Basis Citation
Claim 14	The catalyst of Claim 13 wherein said primary transition metal is delivered to said support as a solvent containing a predetermined concentration of a first transition metal precursor defined as a transition metal complex having at least one ligand and wherein said ligand is absent of sulfur, chlorine, sodium, bromine, and iodine, and wherein said promoter is delivered to said transition metal inclusive support as a solvent containing a predetermined concentration of said a second transition metal precursor defined as a transition metal complex having at least one ligand and wherein said ligand is absent of sulfur, chlorine, sodium, bromine, and iodine.	Page 9, Line 5 – Page 10, Line 9: Provides a description of preparation methods, including recommended precursors and delivery methods.
Claim 15	The catalyst of Claim 14 wherein said first transition metal precursor is a transition metal complex having ligands selected from the group consisting of ammonia, primary amines, secondary amines, tertiary amines, quaternary amines, nitrates, nitrites, hydroxyl groups, carbonyls, carbonates, aqua ions, oxides, oxylates, and combinations thereof.	Page 9, Line 23 – Page 10, Line 2: "... some representative "clean" precursors would include complexes having ligands selected from the group consisting of ammonia, primary amines, secondary amines, tertiary amines, quaternary amines, nitrates, nitrites, hydroxyl groups, carbonyls, carbonates, aqua ions, oxides, oxylates, and combinations thereof."
Claim 16	The catalyst of Claim 14 wherein said first transition metal precursor is selected from the group consisting of platinum tetra-amine hydroxide, platinum tetra-amine nitrate, platinum di-amine nitrate and a combination thereof.	Page 10, Lines 3 – 5: "For example, for the platinum containing catalysts, the platinum may be delivered to the support in the form of a platinum tetra-amine hydroxide solution, a platinum tetra-amine nitrate, a platinum di-amine nitrate, platinum oxalate, platinum nitrate or other similar platinum-based complexes." Claim 16 as originally filed: "and a combination thereof."
Claim 17	The catalyst of Claim 14 wherein said second transition metal precursor is selected from the group consisting of ammonium perrhenate, a rhenium oxide complex, ReO_2, ReO_3 or Re_2O_7.	Page 10, Lines 8 – 10: "Similarly, the rhenium may be provided as a clean precursor in the form of ammonium perrhenate or as one of the known rhenium oxide complexes, such as ReO_2, ReO_3 or Re_2O_7.
Claim 19	The catalyst of Claim 13 wherein said [Primary TM] and [Promoter] define a ratio [Primary TM]:[Promoter] that is greater than 1:1.	Page 5, Lines 5 – 9: "The transition metal promoter ... is preferably present in the catalyst at a concentration such that the [primary transition metal]:[promoter] is greater than 1:1, *i.e.* the promoter concentration must be less than the primary transition metal concentration."
Claim 20	The catalyst of Claim 13 wherein said catalyst is combined with a substrate, wherein said substrate is a monolith, a foam, a sphere, an extrudate, a tab, a pellet, a multi-passage substrate or a combination thereof.	Page 5, Lines 23 – 24: "The present catalyst may similarly be delivered on a variety of substrates, such as monoliths, foams, spheres, or other forms as are known in the art." Page 11, Lines 7 – 8: "For example, the present catalyst may be delivered in the form of extrudates, tabs, pellets, multi-passage substrates or similarly prepared materials."

Claims Appendix

Claim 1. A catalyst suitable for production of hydrogen, said catalyst consisting essentially of:

a. a primary transition metal selected from the group consisting of a Group VIII metal, a Group IB metal, cadmium and a combination thereof, said primary transition metal being present at a predetermined concentration [Primary TM];

b. a transition metal promoter present at a predetermined concentration [Promoter] selected such that a ratio defined by [Primary TM]:[Promoter] is greater than 1:1; and

c. a support material comprising cerium oxide and an additive selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof,

wherein said transition metal and said promoter are combined with said support material to form said catalyst.

Claim 2. The catalyst of Claim 1 wherein said primary transition metal is present at a concentration of up to about 20 wt%.

Claim 3. The catalyst of Claim 2 wherein said primary transition metal is selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof.

Claim 4. The catalyst of Claim 1 wherein said promoter is selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof.

Claim 5. The catalyst of Claim 1 wherein said support material comprises cerium oxide at a concentration of greater than about 10 wt%.

Claim 6. The catalyst of Claim 1 wherein said support material has a surface area of from about 10 m^2/g to about 200 m^2/g.

Claim 7. The catalyst of Claim 1 wherein said catalyst is combined with a substrate, wherein said substrate is a monolith, a foam, a sphere, an extrudate, a tab, a pellet, a multi-passage substrate or a combination thereof.

Claim 8. A catalyst suitable for conversion of hydrogen, said catalyst comprising:

a. a primary transition metal present at a predetermined concentration [Primary TM] of up to about 20 wt% and selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof;

b. a transition metal promoter present at a predetermined concentration [Promoter] and selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof; and

c. a support material comprising cerium oxide at a concentration of greater than about 10 wt%, and an additive present at a concentration of up to about 90 wt% and selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof,

wherein said transition metal and said promoter are combined with said support material to form said catalyst and a ratio defined by [Primary TM]:[Promoter] is greater than 1:1.

Claim 11. The catalyst of Claim 8 wherein said support material is a mixed cerium zirconium oxide comprising zirconium at a higher weight percent than cerium.

Claim 12. The catalyst of Claim 8 wherein said support material is a mixed cerium zirconium oxide comprising cerium at a higher weight percent than zirconium.

Claim 13. A catalyst suitable for conversion of hydrogen for chemical processing, said catalyst comprising:

a. a primary transition metal present at a predetermined concentration [Primary TM] of up to about 20 wt% and selected from the group consisting of iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, cadmium and a combination thereof;

b. a transition metal promoter present at a predetermined concentration [Promoter] and selected from the group consisting of lithium, potassium, rubidium, cesium, titanium, vanadium, niobium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel, copper, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, gold, and a combination thereof; and

c. a support material comprising cerium oxide at a concentration of greater than about 10 wt%, and an additive present at a concentration of up to about 90 wt% and selected from the group consisting of gadolinium, samarium, zirconium, lithium, cesium, lanthanum, praseodymium, manganese, titanium, tungsten, neodymium and a combination thereof,

wherein said transition metal is impregnated onto the support material to form a transition metal inclusive support and said inclusive support is then calcined; and said transition metal promoter is impregnated onto said inclusive support and calcined to form a promoter inclusive catalyst.

Claim 14. The catalyst of Claim 13 wherein said primary transition metal is delivered to said support as a solvent containing a predetermined concentration of a first transition metal precursor defined as a transition metal complex having at least one ligand and wherein said ligand is absent of sulfur, chlorine, sodium, bromine, and iodine, and wherein said promoter is delivered to said transition metal inclusive support as a solvent containing a predetermined concentration of said a second transition metal precursor defined as a transition metal complex having at least one ligand and wherein said ligand is absent of sulfur, chlorine, sodium, bromine, and iodine.

Claim 15. The catalyst of Claim 14 wherein said first transition metal precursor is a transition metal complex having ligands selected from the group consisting of ammonia, primary amines, secondary amines, tertiary amines, quaternary amines, nitrates, nitrites, hydroxyl groups, carbonyls, carbonates, aqua ions, oxides, oxylates, and combinations thereof.

Claim 16. The catalyst of Claim 14 wherein said first transition metal precursor is selected from the group consisting of platinum tetra-amine hydroxide, platinum tetra-amine nitrate, platinum di-amine nitrate and a combination thereof.

Claim 17. The catalyst of Claim 14 wherein said second transition metal precursor is selected from the group consisting of ammonium perrhenate, a rhenium oxide complex, ReO_2, ReO_3 or Re_2O_7.

Claim 19. The catalyst of Claim 13 wherein said [Primary TM] and [Promoter] define a ratio [Primary TM]:[Promoter] that is greater than 1:1.

Claim 20. The catalyst of Claim 13 wherein said catalyst is combined with a substrate, wherein said substrate is a monolith, a foam, a sphere, an extrudate, a tab, a pellet, a multi-passage substrate or a combination thereof.